R·I·T Title: Rudolf Ellipsometer Auto-EL IV

Semiconductor & Microsystems

Fabrication Laboratory **Revision**: **C** **Rev Date:12/07/17**

Approved by:

_____ / / _____ / /

Process Engineer Equipment Engineer

1 SCOPE

The purpose of this document is to detail the use of the Rudolph Ellipsometer Auto-EL IV. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in loss of privileges.

2 REFERENCE DOCUMENTS

- Rudolph Auto EL MS Manual
  (Available by the tool)

3 DEFINITIONS

N/A

4 TOOLS AND MATERIALS

4.1 General Description

The Rudolph Ellipsometer is used to measure film thickness as well as optical properties of thin films deposited on a substrate. Included in this manual is a listing of the available programs and patterns. There are patterns that will measure a single point or multiple points for various sized wafers.

5 SAFETY PRECAUTIONS

5.1 Hazards to the Operator

5.1.1 The wafer stage changes position and may create a pinch hazard.

5.2 Hazards to the Tool

5.2.1 Do not manually move the stage – **ever!**

5.2.2 Do not remove any tool covers.

6 INSTRUCTIONS

6.1 Initial State Check

6.1.1 Enable the system by activating the tool via **CARD ACCESS #1**.

6.1.2 Make sure that the Main Power is **ON** using the key switch located on the left side. The machine will respond by going through an initialization process.

6.1.3 Press the **ESCAPE** button to enable the display.

6.1.4 Turn **ON** the **PRINTER POWER** switch on top of the tool.

6.1.5 Allow the ellipsometer to warm up for 15 minutes. This stabilizes the lamp output.

6.2 Resetting the System

6.2.1 If you need to back out of a measurement, press the **ESCAPE** button to return to the main prompt.

6.2.2 Pressing the red **RESET** button under the black cover will bring the machine back to the point where you can align the sample. This can be done at any time.

6.3 Operating the system

6.3.1 **Aligning a Sample**

6.3.1.1 The display will read "**Insert sample - press CONTinue**".

6.3.1.2 Place sample on stage, centered within the vacuum rings.

6.3.1.3 Turn **ON** the **STAGE VACUUM** valve located on back of tool.

6.3.1.4 Press **CONT**inue button.

6.3.1.5 The display will read **"Please wait - moving stage"**.

6.3.1.6 Turn on the black **ALIGNMENT LAMP** switch located in the upper right corner.

6.3.1.7 To adjust the sample height, pull the **40x OBJ**ective slider away from the instrument to its forward stop. Loosen the **HEIGHT ADJ. LOCK**ing screw by turning the hex key **counter clockwise ½ turn**. While looking into the eyepiece, adjust the height with the **HEIGHT ADJ.** ring until the sample features or the white spot appear in sharp focus.

6.3.1.8 Tighten the **HEIGHT ADJ. LOCK**ing screw by turning the hex key **counter clockwise** until the screw is snug. **DO NOT OVERTIGHTEN.**

6.3.1.9 To adjust the stage tilt, look through the eyepiece at the spot of white light. Use the three tilt adjustment knobs **L**, **F** and **R** (left, front and right), located under the wafer stage, to center the white spot on the crosshairs.

6.3.1.10 When all alignments are complete, press the **CONT** button, push the **40x objective** slider back in and turn off the **ALIGNMENT LAMP** switch.

6.3.2 **Measurement**

6.3.2.1 Center the sample on instrument stage.

6.3.2.2 Turn on the **STAGE VACUUM** switch.

6.3.2.3 The display should read "Press **RUN**, **LEARN**, or **CONT**inue". If this isn't the case, press the **ESCAPE** button and wait for the prompt.

6.3.2.4 Press the **RUN** button.

6.3.2.5 When prompted, enter the **Pattern #** and **Program #**, then press the **ENTER** button. See appendix for a detailed listing of patterns and programs. Patterns include measurement locations in (***r***, ***θ***) format where ***r*** is the radius in ***mm***. The pattern that you select will depend on the film or film stack being measured as well as

the film thickness. Depending on the program, you may be asked to enter certain information about the film or film stack that you are measuring.

Pattern 20	measures the center of the wafer one time
Pattern 22	measures 5 spots on a 100mm wafer
Pattern 28	measures 5 spots on a 150mm wafer

Program 03	measures **oxide** thickness
Program 07	measures **nitride** thickness
Program 20	measures **oxide or nitride** thickness and index of refraction
Program 32	measures **polysilicon on oxide**/ you will supply the **spec thickness** (approximate polysilicon thickness), the **TL** (oxide thickness) and the **NL** (oxide index of refraction ***n=1.460***).

6.3.2.6 Specify Approximate Thickness, and press the **ENTER** button. The results will be printed out on top of the ellipsometer.

6.3.2.7 To make another measurement load the wafer, turn **ON** the **STAGE VACUUM** and press the **CONT** button at the "Press **RUN**, **LEARN**, or **CONT**inue" prompt.

6.3.3 **Standby**

6.3.3.1 Turn **OFF** the **ALIGNMENT LAMP**.

6.3.3.2 Turn **OFF** the **STAGE VACUUM**.

6.3.3.3 Turn **OFF** the **PRINTER POWER** switch.

6.3.3.4 Log **OFF** the tool at **CARD ACCESS #1**.

6.3.4 **Shutdown**

6.3.4.1 Turn **OFF** the **MAIN POWER** switch.

6.3.4.2 Turn **OFF** the **STAGE VACUUM** switch.

6.3.4.3 Log **OFF** the tool at **CARD ACCESS #1**.

6.4 Errors during Run

6.4.1 If the printer paper sticks, carefully pull the paper while pressing the **FEED** button.

7 APPROPRIATE USES OF THE TOOL

7.1 For measurement of absorbing and transparent films on various substrates, refer to Auto El MS manual sections 4 and 5 for specific information.

8 ATTACHMENTS

8.1 Programs

Prog.	Meas. Routine	Calc. Routine	Print Format	Ident. Option	Spec. Thick	Lambda	Phi	NU	NU Guess	TL	NL	KL	NS	KS
00	02	24	05	00	*	*	70.00		*	*	1.460		3.858	0.018
01	02	10	07	02	1000	6328								
02	02	10	00	00	*	6328	70.00		*				3.858	0.02
03	02	11	07	00	100	6328		*						
04														
05	02	32	0	00	100	8300	70.00		*				3.858	0.018
06	02	13	04	01	100	4050	70.00	1.470					5.420	0.329
07	08	21	00	00	1500			2.000		500	.460			
08	08	13	04	01	100	4050	70.00	1.470					5.420	0.329
09	00	12	00	00	1000	6328	70.00	CALC	1.46				3.858	0.018
10	08	13	04	01	20.0	6328	70.00	1.461					3.875	0.016
11	08	12	04	01	20.0	6328	70.00	CALC	1.46				3.875	0.016
12	08	49	04	01	1000	6328	70.00	1.47		100	.460	0	3.875	0.016
13	08	12	04	01	50	6328	70.00	CALC	1.62				3.875	0.016
14	08	13	04	01	50	6328	70.00	CALC	1.62				3.875	0.016
15	02	13	04	01	100	6328	70.00	2.020					3.883	0.019
16	02	13	04	01	2000	6328	70.00	2.020					3.883	0.019
17	08	12	04	01	1000	6328	70.00		1.46				3.875	0.016
18	02	13	04	00	1000	8300	70.00	1.455					3.672	0.050
19	02	13	04	00	45.0	4050	70.00	1.470					5.420	0.329
20	02	10	07	00	*									
21	02	11	07	00	*			*						
22	02	12	07	00	*	8300	70.00	CALC	1.45				3.672	0.005
23	02	13	07	00	*	8300	70.00	*					3.672	0.005
24	02	12	07	00	*	4050	70.00	CALC	1.47				5.420	0.329
25	02	13	07	00	*	4050	70.00	*					5.420	0.329

26	02	10	06	01	1000			CALC						
27	02	11	06	01	1000			1.460						
28	02	12	06	01	1000	8300	70.00		1.45				3.672	0.005
29	02	13	06	01	1000	8300	70.00	1.455					3.672	0.005
30	02	12	06	01	1000	4050	70.00		1.47				5.420	0.329
31	02	13	06	01	1000	4050	70.00	1.470					5.420	0.329
32	02	49	06	00	*	6328				*	*	0	3.858	0.018
33	02	49	06	00	*	8300				*	*	0	3.672	0.005
34	02	00	06	00		*								
35	02	70	06	00		*	70.00							

8.2 Patterns

Pattern	# of Points	Wafer Size	Point Location (r,theta)
0	5		(0,0)(30,45)(30,135)(30,225)(30,315)
1	5		(0,0)-**same point 5 times**
2	5		(0,0)(38.1,45)(38.1,135)(38.1,225)(38.1,315)
3	15	100mm	(49,90)(42,90)(35,90)(28,90)(21,90)(14,90)(7,90)
			(0,0)(7,270)(14,270)(21,270)(28,270)(35,270)
			(42,270)(49,270)-**15 points in a straight line**
20	1		(0,0)
21	5		(0,0)-**same point 5 times**
22	5	100mm	(0,0)(40,0)(40,90)(40,180)(40,270)
23	9	100mm	(0,0)(20,0)(20,90)(20,180)(20,270)(40,0)(40,90)
			(40,180)(40,270)
24	20	100mm	(0,0)(15,0)(15,90)(15,180)(15,270)(30,0)(30,60)
			(30,120)(30,180)(30,240)(30,300)(45,0)(45,40)(45,80)
			(45,120)(45,160)(45,200)(45,240)(45,280)(45,320)
25	5	125mm	(53,0)(53,90)(53,180)(53,270)
26	9	125mm	(0,0)(26,0)(26,90)(26,180)(26,270)(53,0)(53,90)
			(53,270)
27	20	125mm	(0,0)(19,0)(19,90)(19,180)(19,270)(38,0)(38,60)
			(38,120)(38,180)(38,240)(38,300)(57,0)(57,40)
			57,80)(57,120)(57,160)(57,200)(57,240)(57,280)(57,320)
28	5	150mm	(0,0)(65,0)(65,90)(65,180)(65,270)
29	9	150mm	(0,0)(32,0)(32,90)(32,180)(32,270)(65,0)(65,90)
			(65,180)(65,270)
30	20	150mm	(0,0)(23,0)(23,90)(23,180)(23,270)(46,0)(46,60)
			(46,120)(46,180)(46,240)(46,300)(69,0)(69,40)
			(69,80)(69,120)(69,160)(69,200)(69,240)(69,280)(69,300)

Description

***** indicates that you will have to enter a value during a run

Calculation Routine

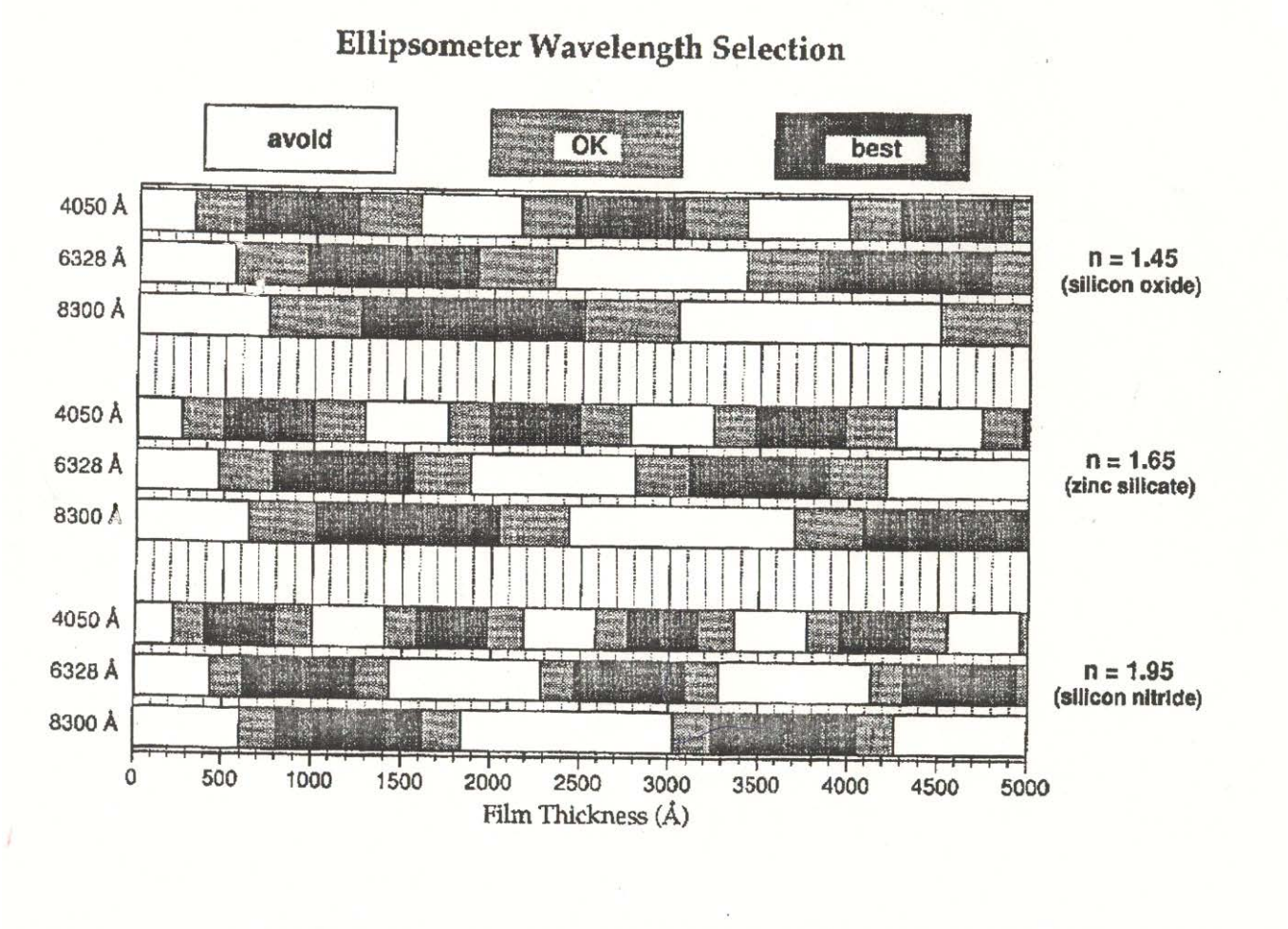
70 optical constants of bare substrates
49 polysilicon over single film on substrate
31 absorbing single films
10 use 6328
11 use 6328

Measurement Routine

0 no measurement performed
2 2 zones, higher accuracy
8 2/1 zones, fastest, medium accuracy

Print Format

0 prints only calculated values
6 prints calculated values, measurement routine#, calculation routine#, delta, psi, cycle thickness, r-theta coordinates, P's and A's.
7 same as 6 with the addition of the orders



REVISION RECORD

Summary of Changes	Originator	Rev/Date
Original Issue	Sean O'Brien	A-02/05/03
Added card access and stage tilt/sample height adjustment instructions	Scott Blondell	B-10/15/03
Corrected the order of 6.3.7-6.3.9, and position of vacuum valve	Bruce Tolleson	**C-12/07/17**